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Effect of Different Levels of Palm Kernel Cake on Broiler Performance

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The experiment examined how varying Palm Kernel Cake (PKC) amounts affected broiler growth. 200 10-day-old broiler chicks were randomly assigned to three treatment groups. Ten birds per replication in each of the seven groups. PKC at 0, 2, and 4% was used to create three experimental diets. This 35-day experiment has two phases: broiler starter (1-21 days) and finisher (22-35 days). Birds had clean water 24/7. Daily feed intake, weekly weight increase, and starter/finisher FCR were recorded. After this trial, two birds were randomly selected from each replicate, weighed for live weight, and slaughtered to ascertain carcass weight, breast weight, thigh weight, gizzard weight, gut length, and abdominal fat weight. This research found that PKC decreased feed intake during starter, finisher, and total phases. A non-significant effect (P >0.05) of three PKC levels on broiler starter and finisher feed consumption was reported. Three PKC levels dramatically reduced broiler weight in both starter and finisher periods. The impact of FCR was substantial (P < 0.05) across various PKC levels. FCR significantly (P <0.05) increased with higher PKC levels in both starter and finisher phases. This study found that PKC levels did not alter carcass weight (P>0.05). As PKC increased, carcass yield, thigh weight, gizzard weight, breast weight, and neck weight remained unchanged. PKC did not impact blood glucose, calcium, urea, triglycerides, or LDL (P>0.05). For varied PKC levels, Hb was non-significant (P>0.05). With increased PKC, blood phosphorous did not change (P>0.05). PKC increases did not influence HDL or red blood cells (P>0.05). Based on studies, PKC in broiler diets may reduce weight increase and FCR.
Keywords: Palm Kernel Cake, feed intake, performance, broiler growth, feed conversion ratio.

INTRODUCTION

The residue remaining after oil extraction from the kernel is referred to as palm kernel cake (PKC). Malaysia ranks among the globe's foremost producers of palm oil, with a plentiful supply of Palm Kernel Cake (PKC) accessible year-round. It is necessary to employ this by-product as an alternative feed for local poultry. This cake is recognized for its potential application as a feed ingredient. PKC serves as an excellent substitute for cotton seed cake (CSC) and is also economically advantageous. It possesses a superior nutritional profile and is cost-effective. PKC is obtained from the extraction of palm kernel oil. It is predominantly cultivated in equatorial climates. PKC, recognized as a beneficial protein and energy source, is gaining popularity in both the livestock and poultry feeding sectors. Its 16-20% crude protein level renders it a distinctive feed item and an excellent substitute for routinely utilized corn-soybean meal combinations. It is primarily advised for ruminant feed for both fattening and dairy purposes. The application of PKC in poultry remains rather uncommon due to certain constraints. The elevated CF values diminish digestibility in poultry, hence adversely impacting output. Numerous efforts have been undertaken to examine the impact of different incorporation levels of PKC on poultry productivity (Onwudike, 1986). The inclusion of PKC in livestock and poultry diets is constrained by its elevated fiber content, abrasive texture, unpalatable taste, comparatively poor amino acid availability, and high copper concentration (Onwudike, 1986; Ojewola and Ozuo, 2006). Nevertheless, certain studies have noted that PKC can be administered to starter and finisher broiler chicks at inclusion levels of 28% and 35% without adversely affecting output (Onwudike, 1986). Okeudo *et al.*(2005); Okeudo *et al.* (2006) demonstrated that broilers consuming a 30% PKC diet during the finisher phase had growth rates comparable to those fed a 0% PKC diet. Panigrahi and Powell (1991) shown that the addition of methionine and lysine enables broilers to be fed diets with 40% PKC. The incorporation of PKC in chicken

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feeds enhances the health and immunity of the birds (Sundu *et al*., 2003). The CP, energy, and CF values render it a superior feed element, particularly for ruminants. The primary objective of any feed formulation is to meet the crude protein (CP) and energy requirements of broilers, a goal often neglected in our nation. Regarding CP and energy needs, birds can utilize alternative feed ingredients such as palm kernel cake (PKC) (Shakila *et al*., 2012). PKC is mostly utilized as a feed resource in the areas where it is predominantly cultivated. Its use in poultry is not more prevalent due to its high fiber content. Numerous research has examined chicken diets through physical, chemical, biological, or a combination of modifications to enhance the nutritional quality of PKC. Only a marginal enhancement in nutritional levels was noted following the chemical or biological treatment of PKC. Optimal results were noted in solid-state fermentation (SSF) employing fungus, which enhanced the nutritional quality of PKC. It reduced CF content and elevated the concentration of CP. This approach to enhancing the nutritional quality of PKC is both feasible and economical, making it suitable for incorporation into chicken feed. PKC is regarded as the most versatile feed component and is extensively utilized in many poultry feeds. The potential of PKC has become increasingly significant and promising due to forthcoming research on PKC. Methods such as enzyme treatment and solid-state fermentation were employed to enhance the nutritional content of palm kernel cake (PKC) for use as a primary feed element in chicken. Competition arises among food, feed, and fuel, resulting in a scarcity of traditional feed resources for cattle. Researchers continually seek cost-effective feed alternatives that are readily available throughout the year. The lack of availability negatively impacts animal output. Traditionally, farmers have employed CSC as a source of vegetable protein for animal feed. The heightened demand for CSC occasionally renders it scarce, thereby driving up its price. Pesticides and adulterants in cakes containing inferior ingredients diminish their quality and consequently negatively impact poultry. PKC is devoid of anti-nutritional elements such as aflatoxins. Additionally, PKC has been utilized as a feed ingredient in several feeding trials involving poultry, ruminants, and swine. PKC is regarded as a beneficial element from both protein and energy perspectives, and it is typically utilized as a protein source. The protein concentration ranges from 10.0% to 19.8%. PKC possesses modest levels of protein and carbohydrates nutritionally. The chemical examination of PKC indicated that its nutritious composition varies significantly based on the oil extraction method, the palm nut species, and the residual shell content in the meal. The water retention capacity of PKC is fifty percent that of copra meal (Sundu *et al*., 2003). The study was designed to assess the impact of varying amounts of PKC on broiler performance, specifically focusing on weight increase and feed conversion ratio (FCR). The aim of this study was to assess the impact of varying levels of PKC on the performance, digestibility, and internal organs of broilers.

MATERIALS AND METHODS

***Location of Research and Duration*:** The trial was conducted at Department of Animal Sciences, College of Agriculture, University of Sargodha. Diets were formulated by using different levels of PKC and were fed to the 360 broiler day-old chicks for 35 days.

***Bird Housing and Management*:** All the utensils and farm required for this purpose were cleaned thoroughly and washed with detergent. Farm was completely prepared before the arrival of birds. After placement of litter material and utensils and before arrival of birds, farm was washed and fumigated with 17.5g potassium permanganate and 35ml of formalin (40%) per 100 cube feet of space. Two hundred and ten (210) day-old broiler chicks were purchased from the local hatchery and reared at the broiler research farm of the Department of Animal Sciences. Chicks were divided randomly into 21 replicate pens. During the first week, temperature was maintained at 95°F for brooding of birds and was decreased at the rate of 5°F per week until 75°F, which was maintained throughout the trial. Feed and freshwater were offered *ad libitum* throughout the experimental period.

***Experimental Birds*:** Birds were divided into 3 groups under Completely Randomized Design (CRD). Each group had 7 replicates (21 total replicates) with 10 birds per replicate. The basal diet was formulated according to the nutrient requirements of birds. The following treatments were used.

Table 1. Experimental Diets.

Treatment	PKC %
1	0
2	2
3	4

***Vaccination*:** Chicks were vaccinated against different diseases e.g, New Castle Disease (ND), Infectious Bronchitis (IB), Infectious Bursal Disease (IBD). Schedule of the experiment's vaccination of broilers is given in Table 2.

Table 2. Schedule of the Vaccination of Birds.

Age (Days)	Vaccine	Route
1	ND+IB	Eye drop
10	IBD-I	Drinking water
18	IBD-II	Drinking water
22	ND	Drinking water

ND Stands for Newcastle Disease IBD stands for Infectious Bursal Disease.

Production Performance and Livability

***Initial Weight*:** Upon arrival of chick's initial weight was taken by using an electrical weighing balance. After that birds

were weighed weekly.

***Intake of Feed*:** Feed intake for each replicate pen was noted individually. Daily feed intake was observed and recorded and weekly weight gain was also recorded. Data were used to calculate the feed consumption per bird per day.

***Feed Conversion Ratio (FCR)*:**

FCR was determined by using this formula.

$$FCR = \frac{feed\ itake(g)}{Body\ weight\ gain\ (g)}$$

Carcass Characteristics

***Slaughtering Data*:** Two birds were randomly chosen for each replication, weighed for live weight, and subsequently slaughtered to document carcass features, including dressing %, liver weight, gizzard weight, breast weight, heart weight, thigh weight, abdominal fat weight, and carcass weight. This data were utilized to compute the weight of the gizzard, liver, heart, and abdominal fat, carcass yield, thigh weight, relative weight of breast meat, and dressing percentage.

***Carcass Weight*:** Carcass is the total edible meat from bird. Carcass weight was taken right after Hilal slaughtering of the bird, i.e., complete bleeding; removal of feathers, skull, and internal organ.

***Dressing Percentage*:** Dressing percentage was also being calculated by using formula;

Dressing (%) = (Carcass weight / Live weight) x 100

Table 3. Composition of Starter Experimental Diet (1-21 days).

Ingredients %	PKC1 (%) 0%	PKC2 (%) 2%	PKC3 (%) 4%
Corn	55.8	52.5	49.0
Soybean meal	25.1	25.5	25.7
Canola meal	13.0	13.0	13.0
Oil	2.40	3.60	4.80
PKC	0	2	4
Lysine sulphates	0.31	0.29	0.27
DCP	1.00	1.00	1.00
Limestone	1.20	1.12	1.00
Salt	0.25	0.25	0.26
Soda	0.25	0.24	0.24
DLM	0.21	0.22	0.22
Premix	0.40	0.40	0.40
Threonine	0.10	0.07	0.07
Nutrients %			
Chloride		0.19	
Protein		21.5	
Ash		6.97	
Sodium		0.19	
Metabolize energy		2950kcal/kg	
Digestible lysine		1.20	
Calcium		0.80	
Phosphorous		0.42	

PKC stands for Palm Kernel Cake

Table 4. Composition of Finisher Experimental Diets (22-35 days).

Ingredients %	PKC1 0%	PKC2 2%	PKC3 4%
Corn	63.0	60.5	57.4
Soybean meal	25.0	25.1	25.3
Canola meal	4.0	4.0	4.0
Oil	3.6	4.6	5.7
PKC	0	2	4
DCP	1.3	1.23	1.22
Limestone	1.16	1.13	1.10
Salt	0.30	0.29	0.30
Soda	0.28	0.28	0.28
DLM	0.23	0.24	0.25
Threonine	0.05	0.07	0.07
Premix	0.40	0.40	0.40
Nutrients %			
Phosphorous		0.42	
Calcium		0.8	
Digestible lysine		1.05	
Metabolize energy		3170kcal/kg	
Sodium		0.21	
Chloride		0.21	
Protein		18.8	
Ash		7.3	

***Statistical Data Analysis*:** Data collected during this trial were analyzed under Completely Randomized design. Treatments were compared by using Tukey's test. Statistical analysis was performed by using Statistix 8.1 software.

Table 5. Premix Composition.

Items	Weight/Kg
Vitamin A	0.006g
Vitamin D_3	0.000125g
Vitamin E 50	0.0402g
Vitamin K_3	0.0012g
Vitamin B_2	6g
Vitamin B_3	45g
Vitamin B_5	12g
Vitamin B_6	5g
Vitamin B_9	12.5g
Vitamin B_{12}	12.5g
Manganese ($MnSO_4$)	275g
Ferrous ($FeSO_4$)	150g
Zinc Sulphate ($ZnSO_4$)	200g
Copper Sulphate ($CuSO_4$)	75g
Selenium (4%)	75g
Potassium Iodide)	4g

RESULTS AND DISCUSSION

***Feed intake*:** A non-significant effect (P >0.05) was observed on feed intake during the starter and finisher stages of broiler by the inclusion of 3 levels of PKC (Table 6). This study showed that there was a nonsignificant effect on feed intake with the different amounts of PKC. Our findings were similar with Garcia *et al.* (1999) which showed that higher levels of PKC was not significantly different with respect to feed consumption. Similarly, the present study relates with the findings of Anaeto *et al.* (2009) who reported that high levels of PKC did not affect body weight gain and feed intake. The findings of the present study showed some differences with the Okorie *et al.* (2011) who observed that the feed intake of broilers decreased as per levels of full fat PKC were increased this might be related to high fat and high fiber which reduced the intake of feed. Furthermore, different studies observed that PKC had no effect on feed intake Loh *et al.* (2002).

***Weight Gain*:** A significant effect (P <0.05) was observed on weight gain during starter and finisher stages of broiler. It has been observed that the supplementations of 3 levels of PKC significantly decreased the weight of broilers in both phases i.e. starter and finisher (Table 6)**.** The present study shows that PKC1 has higher weight of broilers but higher degree of PKC3 has lower weight. This was because of high fiber contents that increased with the increasing level of inclusion of PKC in rations. Present findings are similar with the Okorie *et al.* (2011) who observed that the birds fed with the control diet had more weight gain than other dietary levels due to presence of less crude fiber in the control diet of birds. Present findings are also similar with the Anaeto *et al.* (2009) who observed that high level of PKC had a negative effect on body weight gain, by increasing levels of PKC, weight gain decreased, may be due to high fiber contents that increased with the increasing levels of inclusion of PKC.

Present findings are contradictory with the Loh *et al.* (2002) who observed that the 15% inclusion level improved body weight gain fed with enzymes but without enzymes led to decrease in body weight of broilers. Present findings are also contradictory with the Garcia *et al.* (1999) who observed that body weight gain was not significantly different at lower level of PKC. Because high level of PKC had negative impact on the percentage mortality of birds and their inclusion levels were so high (30%). Okorie *et al.* (2011) observed that the average live weight of birds was increased as levels of full fat PKC were increased. Majority of the studies explained that the higher level of PKC had negative impacts on broiler performance because of high fiber contents, which were present in the PKC and these contents were the reason of less body weight gain in the broilers, because the digestibility of feed decreased due to higher fiber contents. Present study is contradictory with the findings of Bello *et al.* (2011) who observed that with the increasing levels of PKC, weight gain of broilers increased with the 30% inclusion level.

***Feed Conversion Ratio*:** The effect of feed conversion ratio was significantly increased (P <0.05) with respect to the increasing levels of PKC. It has been observed that FCR increased with increasing the level of PKC in the both phases of starter and finisher (Table 6).

Different studies had different results on FCR according to different levels of PKC. Present study shows that PKC1 has less FCR than PKC3 having higher PKC inclusion level. Present study is similar with the findings of Anaeto *et al.* (2009)who observed that birds fed high level of palm kernel had more FCR. They reported bad effect of PKC on the efficiency of feed. This might be related to higher fiber contents of PKC containing diets. Higher fiber contents may cause poor digestibility which is ultimately reflected in low feed utilization efficiency.

Table 6. Effect of PKC on Feed Utilization in Broilers.

Feed intake (g)	Diet			SEM	P-value
	PKC1	PKC2	PKC3		
Starter	1277.3	1274.4	1272.0	01.42	0.120
Finisher	2046.1	2044.0	2041.0	11.56	0.150
Total	3323.4	3316.0	3315.1	23.60	0.110
Weight gain (g)					
Starter	880.00^{a}	865.14^{b}	830.00^{c}	09.70	0.001
Finisher	1297.0^{a}	1291.4^{b}	1220.0^{c}	13.90	0.021
Total	2176.1^{a}	2157.0^{b}	2050.0^{c}	18.20	0.011
Feed Conversion Ratio					
Starter	1.45^{c}	1.47^{b}	1.53^{a}	0.02	0.043
Finisher	1.57^{b}	1.58^{b}	1.67^{a}	0.03	0.027
Total	1.52^{c}	1.53^{b}	1.61^{a}	0.03	0.036

PKC1, PKC2 and PKC3 shows the diets containing 0,2 and 4% Palm Kernal Cake respectively.

Significant (P <0.05)^{abc}, within a rows mean sharing different superscripts.

SEM stand for 'standard error of mean'

***Carcass Characteristics*:** The present study showed that the carcass weight was not affected (P>0.05) by different levels of PKC. The carcass yield, thigh weight, gizzard weight, breast weight and neck weight remained unchanged with the increasing levels of PKC (Table 6) As present study showed that the carcass weight was similar for the different standards of PKC. Findings of present study are contradictory with the study of Garcia *et al.* (1999), who reported different result that carcass weight was lowered as levels of PKC increased. Variations in these results may be related to the use of high level of PKC. In present study the level of PKC was far lower than the levels of PKC used in previous studies. So, our findings are contradictory with the other studies because in our study carcass weight has a nonsignificant difference with the different levels Loh *et al.* (2002) of PKC due to less inclusion levels which were 2 and 4%.

Table 7. Effect of PKC on Carcass Characteristics of the Broilers.

Items (g)	Diets(g)			SEM	P-value
	PKC1	PKC2	PKC3		
Carcass weight	1150.0	1140.0	1139.0	18.0	0.1
Gizzard weight	55.0	53.4	52.0	1.80	0.2
Breast weight	450.3	474.0	468.0	10.5	0.2
Neck weight	63.1	64.0	66.1	0.90	0.2
Thigh weight	174.4	173.1	171.3	13.4	0.2

PKC1, PKC2 and PKC3 shows the treatments 0,2 and 4% PKC respectively; SEM stand for 'standard error of mean'

***Blood Chemistry*:** PKC did not affect (P>0.05) blood glucose, blood calcium, blood urea, triglycerides and LDL. Hb was also non-significant (P>0.05) for different levels of PKC.Blood phosphorous did not change (P>0.05) with the increasing levels of PKC (Table 8). HDL and red blood cells also showed that they were not affected (P>0.05) with the increasing levels of PKC (Table 9).

Table 8. Effect of PKC on the Blood Biochemistry of Broilers.

Items (mg/dL)	Diets			SEM	P-value
	PKC1	PKC2	PKC3		
Blood phosphorous	5.35	5.42	5.49	0.08	0.11
Blood urea	5.00	5.01	4.28	0.35	0.15
Blood glucose	236.1	236.0	240.0	11.1	0.12
Blood calcium	9.00	9.01	9.00	0.05	0.13
High density lipoprotein	46.00	45.28	44.01	1.61	0.13
Low density lipoprotein	66.14	65.01	65.00	1.45	0.15
Triglycerides	119.00	118.43	119.01	1.01	0.14
Blood cholesterol	118.00	117.14	118.01	7.39	0.12

PKC1, PKC2 and PKC3 shows the treatments 0,2 and 4% PKC respectively; SEM stand for 'standard error of mean'

Table 9. Effect of PKC on the Hematology of Broilers.

Items	Diets			SEM	P-value
	PKC1	PKC2	PKC3		
Hemoglobin (g/dL)	11.30	12.01	12.00	0.19	0.15
RBC ($x10^6/mm^3$)	3.00	2.49	2.44	0.20	0.18

PKC1, PKC2 and PKC3 shows the treatments 0,2 and 4% Palm Kernal Cake respectively; SEM stand for 'standard error of mean'; RBC = Red blood cells

Present study shows that blood biochemistry had non-significant differences with the increasing levels of PKC. This study was in agreement with Bello *et al.* (2011) who reported that there was no significant treatment effect on blood biochemistry of broilers that described that PKC had no anti nutritional factors. Loh *et al.* (2002) also observed that there was no significant difference among the dietary treatments of blood biochemistry. Majority of studies have same results on blood biochemistry of broilers just like present study that shows non-significant effect of blood biochemistry with the increasing values of PKC due to normal range and less inclusion level used in the diet of broilers.

***Conclusion*:** The study found that broiler diets with 2% and 4% palm kernel cake (PKC) may reduce weight increase and feed conversion ratio (FCR). This shows that PKC at these levels may not optimize broiler growth. PKC's decreased digestibility, fiber content, and anti-nutritional components may explain its lower weight increase and feed efficiency. These unfavorable effects suggest controlling PKC inclusion levels in broiler diets or processing methods to optimize nutritional value and reduce performance issues. Further research may be needed to discover the maximum safe inclusion level or ways to improve PKC digestibility and nutrient availability in broiler feed formulations.

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***Data availability*:** The study's datasets are available upon reasonable request from the corresponding author

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***Consent for publication*:** Not applicable.

***Competing interests*:** All authors declare that there are no competing interests.

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